of flame for which this would be substantially true can be drawn from Callendar's experiments, because he was looking along a thin row of flames in which there was but little lateral extension.

The flames met with in a gas-engine cylinder or in explosion vessels differ from open flames such as can readily be produced in the laboratory, both in respect of the lateral extension which has just been mentioned and also in respect of density. In both these particulars the difference is rather great, the least dimension of the mass of flame in a gas-engine cylinder being only in the smallest sizes comparable with the diameter of the Mêker burner flame, while the density of the gas just after firing in the gas engine is from twenty to thirty times that of the burner flame gases. It does not seem possible from theoretical considerations to determine the effect of these two factors with sufficient accuracy to enable any quantitative inference as to radiation in the gas engine to be drawn from laboratory experiments on flames, but it is useful to discuss their probable qualitative effects.

In Fig. 1, P is the point of observation at which the pyrometer is placed, as in Callendar's experiments, and the portion of the flame from which the radiation is measured is that intercepted by the small cone. If a second similar flame B is placed behind A at a considerable distance, but so that it is intersected by the cone, then the radiation recorded by the pyrometer will be increased, say, by 50 per cent., showing that of the radiation emitted by B and falling on A 50 per cent. is absorbed and the remainder is transmitted to the pyrometer. The absorbed energy is, of course, not lost, but must result in slightly increased radiation from A in all directions. The flame A appears to be a little hotter because of the proximity of B. Thus the increase of radiation absorbed at the pyrometer is due, not only to the radiation transmitted from B, but also to an increase in the intrinsic radiance of A. If the two flames are a considerable distance apart, the latter part is negligibly small, since the flame A does not then receive much radiation from B, and what it does receive is dissipated in every direction. But when flame B is pushed close up to A into the position of B^1 (Fig. 2) this effect may be considerable, and it is obvious that it will be greatly enhanced if the two flames are extended laterally as in Fig. 3. For such case flame A must get rid of the energy which it is receiving by radiation from B^1, mainly by an enhanced radiation in the direction of P. It may therefore be expected that the effect of lateral extension will be to make the flame apparently more transparent.

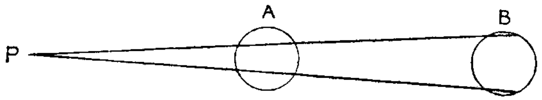

FIG. 1.

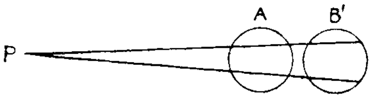

FIG. 2.

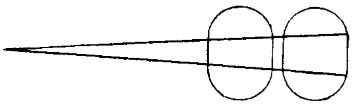

FIG. 3.

To a first approximation it may be expected that the radiating and absorptive powers of a gas at a given temperature will be proportional to its density. That is to say, two geometrically similar masses of flame, in which the temperatures at corresponding points are the same, and the densities in inverse proportion to the volumes (so that the total masses are the same), will radiate in the same way and to the same total amount. It would seem that this must be so, so long as the vibrations of the radiating molecules are the same in character and amplitude in the two cases. For there will then be the same number of molecules vibrating in exactly the same way and arranged in the same way in the two cases. The only difference is in the scale of the arrangement, and this can only affect the matter if the distance between molecules is comparable with the wave-lengths of the radiation emitted, which is not the case. It is only, however, within moderate limits that the molecular vibrations are independent of density. Angström found that the absorption of the radiation from a given source in a tube of CO_2 at ordinary temperature and atmospheric pressure was reduced by increasing the length and diminishing the pressure[1] in the same proportion so as to keep the mass of gas constant. Schäfer found that on increasing the pressure the absorption bands of this gas were widened, so that the curve connecting intensity of radiation and wave-length did not remain of the same shape.[2] These experiments were made at low temperatures, and at the higher temperatures, in which the committee are more particularly interested, there has been but little work. There is no reason to doubt, however, that the character and amount of the radiation from CO_2 and steam at high temperatures will change with the density.

From the point of view of the molecular theory, such a change might be anticipated from either of two causes. An increase of density implies a proportionate increase in the frequency of molecular collisions, and this would result in greater facility of interchange between the translational and atomic types of energy. It is possible that the equilibrium proportion of the two types might be different in consequence. The denser gas may conceivably possess, with a given amount of translational energy, more atomic energy, and therefore radiate more strongly at a given temperature. It is certain that there would be a more rapid attainment of equilibrium in the gas after an explosion or a rapid expansion. Another possible cause is a direct interaction between the molecules, apart from collisions. Two molecules at a sufficient distance apart will vibrate practically independently, each behaving as though the other was not there, except that there will be a tendency for them to vibrate in the same phase. But if the two are close together they react on one another so that the natural period or periods of the two together will not be the same as those which each would have if it were isolated.

Such direct measurements as have been made of the radiation after a closed-vessel explosion suggest that the flame is more transparent than might be inferred from the experiments on open flames. According to information given to the committee by Prof. Hopkinson, W. T. David has found that the radiation received by a bolometer placed outside a fluorite window in the cover of a cylindrical explosion vessel 30 cm. × 30 cm. is greatly increased by highly polishing that portion of the opposite cover which can be "seen" by the bolometer. This implies that a thickness of 30 cm. of flame in these circumstances can transmit much of the radiation which it emits. The density of the gas in this case was atmospheric, and the 30 cm. thickness in the explosion vessel would be equivalent to perhaps 150 cm. of open flame if absorption were simply proportional to density. According to Callendar's experiment, such a thickness would be almost completely opaque. It is possible that the lateral extension is sufficient to account for this result. The open flame should be a cylindrical mass of dimensions 150 cm. × 150 cm., instead of a long strip with a cross-section of 3 cm., in order to make the two cases strictly comparable. It will be remembered that in the discussion above it appeared that the laterally extended flame would seem to be more transparent.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Walsingham medal for 1910 has been awarded to A. V. Hill, of Trinity College. A second medal has been awarded to J. C. F. Fryer, of Gonville and Caius College.

The following have been elected to the Clerk Maxwell scholarship:—R. D. Kleeman and R. T. Beatty, both of Emmanuel College.

At a meeting of the Fitzwilliam Museums syndicate, held on November 29, F. W. Green, of Jesus College, was appointed honorary keeper of the Egyptian antiquities.

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[1] Ark. for Mat. Astron. och Fysik, Stockholm, vol. iv., No. 30, p. 1.

[2] Ann. der Physik, vol. xvi. (1905), p. 93.

Oxford.—At a Convocation held on December 6, the Vice-Chancellor (Dr. Heberden, Principal of Brasenose) presiding, the honorary degree of doctor of science was conferred on Prof. Meldola, F.R.S., professor of chemistry in the Finsbury Technical College (City and Guilds of London Institute), in anticipation of the Herbert Spencer lecture to be delivered by him on December 8. In making the presentation, the Sedelian professor natural philosophy, Prof. A. E. H. Lowe, F.R.S., delivered the following oration:—

"Adest vir quem omnes, qui scientiae et imprimis Chemiae et Biologiae student, ornare gaudent, Societatis Regalis Sodalis, Societatum Entomologiae, Chemiae, Chemicorum industriae, operam dantium Praeses emeritus, Raphael Meldola. Qui vir cum prima aetate Carolo Darwin coniunctissimus esset, ita de Natura formarum novarum creatrice quaesivit ut plurimis eodem studio incensis illud Biologiae genus quod ipse excoluerat nostratium fere proprium fieret. Posteriora eius studia partim in Physice, partim in Chemia versata sunt, quo e numero si pauca quaedam momenti maximi commemorare liceat, et eligerem quae de Chemia Photographiae inserviente, de chemicis carbonis elementis, de chemica umorum corporalium compositione commentus est. Multos iam annos in hoc Chemiae genere principem habitum atque latissimo in campo evagatum nescio an nemo hunc virum laude superavit."

The annual prize distribution and students' conversazione of the Northampton Polytechnic Institute, Clerkenwell, E.C., is to be held this evening, December 8. The Right Hon. Lord Alverstone, G.C.M.G., P.C., Lord Chief Justice of England, will distribute the prizes and certificates. Lecturettes will be given by Mr. F. M. Denton on commercial uses of electro-magnets, and Mr. F. Handley Page on how to fly.

Dr. Edgar F. Smith has been appointed to succeed Dr. C. C. Harrison as provost of the University of Pennsylvania, in which institution he has held a chair of chemistry since 1888. His chief work has been done in electrochemistry, as a list of his principal publications would show. He is a past-president of the American Chemical Society and of the American Philosophical Society. He has also been a member of the U.S. Assay Commission and adviser in chemistry to the Carnegie Institution.

The annual conversazione of the Royal College of Science and Royal School of Mines will be held on Wednesday, December 21. Both the new and old buildings will be open in Imperial Institute and Exhibition Roads, South Kensington, S.W., and many interesting exhibits will be shown in chemistry, physics, mechanics, metallurgy, mining, botany, and zoology, arranged by the respective scientific societies. During the evening Dr. C. Gilbert Cullis will give a lecture on "Coral Islands."

It is announced, says *Science*, that Mr. Andrew Carnegie has given a further sum of 300,000*l*. for the construction of buildings of the Carnegie Technical Schools at Pittsburgh. From the same source we learn that by the will of Prof. A. Marshall Elliott the Johns Hopkins University receives his library, and the sum of 400*l*. for the establishment of a scholarship for graduate students; and that the American Museum of Natural History receives 5000*l*. by the will of the late Mr. Charles E. Tilford, of New York City.

Steps are being taken to inaugurate a Students' Union in connection with Sheffield University. An influential committee, representative of all faculties, has been elected from amongst the members of the Students' Representative Council to proceed with the formation of the union. Sheffield University stands alone amongst the universities of the United Kingdom in not possessing such an institution, and we feel sure that the committee's appeal to members of the University and their friends for contributions to the fund to provide premises where students may be united in the bonds of social intercourse will meet with a generous response. Cheques may be made payable to Mr. H. Khalifa, honorary secretary and treasurer to the Students' Union Committee, The University, Sheffield.

The Royal Agricultural College, Cirencester, founded in 1845 and reorganised in 1908, is now definitely associated with the University of Bristol for the purpose of instruction in agriculture, forestry, estate management, land surveying, veterinary science, natural history, agricultural chemistry, botany, zoology, and geology, to which other allied subjects may subsequently be added. Instruction given at the college in these subjects to undergraduates will be deemed to be instruction given in and by the University for the purpose of degrees and diplomas in agriculture and forestry. The present principal, Mr. Ainsworth-Davis, is recognised as professor of natural history in the University, and Mr. Drysdale Turner as professor of agriculture, this recognition carrying with it membership of the University Senate. While the association will in no way interfere with the primary work of the Royal Agricultural College, which will still retain its distinctive and time-honoured diploma, a new class of students will come into existence, and an important advance be made in the correlation of agricultural education in the west of England.

Under the auspices of the London County Council, another conference of teachers will be held on three days, Thursday, Friday, and Saturday, January 5, 6, and 7, 1911, at Birkbeck College, Bream's Buildings, Chancery Lane, E.C. The programme includes the following subjects, among others:—Thursday, January 5, *Specialisation in Schools*: Addresses by Mrs. Sophie Bryant on the value of specialisation in secondary schools, and F. Bulley on an experiment in specialisation in elementary schools. *Memory*: Addresses by Dr. C. Spearman on the relation of the memory to the will, Dr. E. O. Lewis on some interesting investigations on memory, and Dr. F. H. Hayward on the cultivation of memory. Friday, January 6, *The Teaching of Geography*: Addresses by B. C. Wallis on the teaching of geography in secondary schools, J. Fairgrieve on a practical room for the teaching of geography, and C. J. Rose on open air teaching in geography. Saturday January 7, *Education Experiments in Schools*: Addresses by B. Lewis on a combined scheme of history and geography teaching, E. Thomas on pictorial aids for the teaching of geography and history, A. G. Gawler on how to secure individual work in large classes, J. Greer on an experiment in number teaching, A. E. D. Lowden on stencilling—a valuable form of handwork, and Mrs. Sandford on animals in infants' schools. No charge will be made for admission to the conference. Application for tickets of admission should be made to the Chief Inspector, London County Council, Education Offices, Victoria Embankment, W.C.

By the passing of the Education (Choice of Employment) Bill into law on the day of dissolution of Parliament, the English and Welsh local education authorities have after a keen controversy been accorded statutory powers to "give boys and girls information, advice, and assistance with respect to the choice of employment." The School Boards of Scotland were put in possession of these powers by the Education (Scotland) Act, 1908, and the School Board of Edinburgh took the lead in making the powers operative. The originator of the conception of a national system of school information and employment bureaux was Mrs. Ogilvie Gordon, D.Sc., who first placed her scheme before the public at the annual meeting of the Glasgow Union of Women Workers, held in March, 1904. The full draft of her scheme was submitted to the President of the Board of Education and to the Secretary for Scotland, and was supported by numerous resolutions passed in its favour at public meetings. It was afterwards published in Mrs. Ogilvie Gordon's "Handbook of Employments" (Aberdeen: Rosemount Press). The aim of the scheme is to bring the teachers' knowledge of the individual boy and girl effectively to bear upon their choice of a future career, and it is based upon the sound economic principle that work on such lines ought to be nationally organised in order to make sure that it should reach every child, and that the work ought to cover all the openings and occupations for our youth—skilled or unskilled, mercantile or personal. By the measure which has at last become law, there is now a prospect of an effective advisory service being organised throughout the country, administered by committees formed under the education authorities, and there should be no difficulty in arrangements being made locally between the labour exchanges and the education authority, so that no actual overlapping of work shall take place, but each be helpful to the other.

THE annual prize distribution of the Sir John Cass Technical Institute was held on Tuesday, November 29, when Sir William Tilden distributed the prizes and delivered an address; the chair was taken by Sir Owen Roberts, chairman of the governing body. Sir William Tilden, after contrasting the conditions available for obtaining scientific instruction now, in such institutions as that of the Sir John Cass, as compared with his own student days, referred especially to the improved character of the teaching, but pointed out that the responsibility for gaining the full benefit of these advantages rested still, as it did in former years, far more with the students than with the teachers. Whilst the business of the teachers was to be regarded as being concerned with the selection of the subjects to be studied rather than their exposition, the real responsibility for progress must always rest with the student. The assimilation of knowledge is the business of the student, and the greatest inducement and stimulus for such assimilation is the desire for knowledge, a desire which is most advantageously associated with a conviction of ignorance. Sir William Tilden further urged the necessity of the thorough understanding of the subjects taught at each stage of progress, and pointed out that students should not look to their teachers for recipes for doing things, but to their own efforts, as the means of acquiring a full understanding of their work, and that they should not omit becoming fully conversant with the history and meaning of the expressions and words employed in their studies. In conclusion, it was pointed out that with every student there are times when the mind should be allowed to relax a little from the pages of their text-books, and that of the many forms of relaxation it was most desirable that all young English men and women should devote some attention and interest to the history of their own country. The exceptional advantages of London, and especially of the City of London, as a stimulant to such study was particularly referred to, for there is nothing more interesting, more absorbing, or more enchanting than the study of the history of mankind, especially that particular variety of mankind which is represented by the Anglo-Saxon race. Sir William Tilden subsequently opened the new chemistry laboratory which has recently been equipped by the governors of the institute.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 24.—Sir Archibald Geikie, K.C.B., president, followed by Mr. A. B. Kempe, vice-president, in the chair.—Sir Norman **Lockyer**: The sequence of chemical forms in stellar spectra.—A. **Mallock**: Influence of viscosity on the stability of the flow of fluids. The effect of this paper is to direct attention to an observation made by the late Mr. W. Froude, F.R.S., with regard to an experiment on fluid jets, and to its application in explaining some of the phenomena presented by the flow of viscous fluids. The experiment referred to was shown by Froude at the British meeting of the British Association in 1875, and one of the deductions drawn from it was that in a viscous flow the character of the stream differed according as to whether the flow was towards decreasing or increasing pressure.—Horace **Lamb**: Atmospheric oscillations. The paper treats of the free oscillations of an atmosphere, the temperature being a function of the altitude, and the adiabatic laws of expansion being assumed. In particular, the case of a uniform temperature gradient is discussed in some detail. The possible oscillations are of various types, of which the most important is of the character of a longitudinal wave. The results are simplest when the equilibrium state is one of convective equilibrium, and the velocity of the longitudinal wave is then equal to the Newtonian velocity of sound, $\sqrt{(gH)}$, corresponding to the temperature of the lowest stratum. The bearing of the results on Kelvin's theory of the semi-diurnal barometric oscillation is examined, and it appears that the existence of a free period of the earth's atmosphere, of somewhat less than twelve mean solar hours, is highly probable. Other types of oscillation depend for their frequency on the degree of stability of the atmosphere, and may in circumstances be comparatively slow. It is possible that these may account for some of the minor fluctuations of the barometer. The paper includes also an examination of the theory of waves at a surface of discontinuity.—P. J. **Kirkby**: A theory of the chemical action of the electric discharge in electrolytic gas and other gases. The complicated results attending the passage of an electric discharge through electrolytic gas, described in previous papers, and in particular the chemical effects observed in the positive columns of long discharges, were explained by the theory that the chemical action is due to molecular dissociation effected by the collisions of gaseous ions constituting the current with the molecules of the gas, the atoms of which are thus set free to enter into new combinations. In this paper an account is given of experiments designed to determine both the number of molecules of water (w) formed by the passage of the atomic charge through 1 cm. of the positive columns of various discharges passed through electrolytic gas ($2H_2+O_2$), and also the electric force (Y) within these columns, the results providing data for testing and developing the theory. The chemical effects of the positive column are attributed to the motion of the electrons alone. The number of atoms of oxygen set free by the collisions of an electron moving through 1 cm. in electrolytic gas at p mm. pressure under the electric force Y is of the form $cpe^{-bp/Y}$, where c, b are certain constants. Hence, if an atom of oxygen can unite directly with a *molecule* of hydrogen, w is proportional to $cpe^{-bp/Y}$. All the experimental results satisfy this condition within error-limits in the particular form $w/p = 7{\cdot}9\,e^{-42{\cdot}7p/Y}$, and thus support the above theory as well as the hypothesis that water-vapour is formed by the collision of an atom of oxygen with a molecule of hydrogen. This equation involves that the energy of formation of an oxygen molecule is less than, and probably nearly equal to, $6{\cdot}\times10^{-12}$ ergs; and experiments of Berthelot upon the heat of transformation of ozone into oxygen are shown to be in fair agreement. An estimate, 7×10^{-12} ergs, is also given for the energy of formation of a molecule of water vapour. These experiments also prove, independently of theory, that dissociated atoms of oxygen are not charged electrically. Similar experiments were made with the gaseous mixture $CO+H_2$. The chemical effects observed in the positive column reproduce the main features observed with electrolytic gas, and are explainable by a similar theory.—G. W. **Walker**: An electrostatic voltmeter for photographic recording of the atmospheric potential. The paper describes some experiments made at Eskdalemuir Observatory with the object of obtaining a simple and efficient voltmeter for continuous photographic registration of the electrical potential at a fixed point in the atmosphere. Experience has shown that occasionally the instrument would require to register up to fully 1000 volts + or −. Satisfactory results have been obtained by means of a Dolezalek electrometer. The usual sensitiveness was greatly reduced by using a phosphor-bronze suspension, while the needle was loaded to prevent tilting. A fixed difference of potential is applied between the quadrants by means of one or two standard cadmium cells, while the potential to be measured is applied to the needle. The needle can now carry 1100 volts with perfect safety and stability, while the scale value on the paper is constant to within a few per cent. over a range from −900 to +900 volts. Trial has been made of a voltmeter (made in the workshop) similar in general design to the Dolezalek, but in which the fixed difference of potential between the quadrants is provided by making the quadrants alternately of copper and zinc soldered together and not insulated. Uniformity of scale value has been obtained from about −500 to +500 volts, but for higher potentials only approximate uniformity was secured. This defect arises from want of mechanical perfection of the quadrants and needle, and should disappear in an instrument made with the same accuracy as the Dolezalek. At present, also, the damping of the needle during very rapid changes of potential is insufficient. Reference is made to certain points in the manipulation of sulphur for insulating, which have been found essential to secure good results.—Dr. T. H. **Havelock**: Optical dispersion: an analysis of its actual dependence upon